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DREPANIA
A GENUS OF NUDIBRANCHIATE MOLLUSKS
NEW TO CALIFORNIA

BY

F. M. MACFARLAND
Department of Anatomy
Stanford University, California

Through the kindness of Dr. Myrtle E. Johnson of the San Diego State College, I received while at the Hopkins Marine Station at Pacific Grove, last September, a fine living specimen of a phanerobranchiate Dorid, collected by her at La Jolla, San Diego County, California. After a study of the general external features, the animal was preserved for further examination. The coloration showed that it agreed with a form described by Cockerell in 1901 under the name, *Thecacera velox* Ckll., from the same region, but a slightly more detailed examination made it equally evident that the animal in question is not a *Thecacera* Flem., but belongs to the genus *Drepania* Lafont, in an entirely different subfamily. To fix the status of this interesting member of our molluscan fauna, a brief anatomical study has been made of the specimen, the results of which are presented herewith.

The genus *Drepania* was discovered by A. Lafont at Arcahon on the southwest coast of France, and was described by him in a short paper in the "Journal de Conchyliologie" in 1874, with *Drepania fusca* Lafont as the type species.

Abraham (1877) in his "Revision of the Anthobranchiate Nudibranchiate Mollusca", p. 238, without a personal study of specimens, considered that the differences between *Ancula*

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Lovén and *Drepania* Lafont were not adequate to separate them generically, and reduced the latter to synonymy with the older genus *Ancula* Lovén. But Bergh (1881) in describing *Drepania græffei* from Trieste, in the Northern Adriatic, showed clearly in his brief anatomical study of a single specimen that the new genus was undoubtedly distinct, not only in the external characters listed by Lafont, but also in the radula and mandibular plates. This view was not shared by Fischer in 1883, however, *Drepania* being given subgeneric rank under *Ancula* in his "Manuel de Conchyliologie", p. 525.

A third species, *Drepania tartanella* v. Ihering, was described by von Ihering in 1885, from a specimen taken in the Bay of Naples. A figure of the whole animal, drawn from life, is given as one of the illustrations of the brief description. Von Ihering also records the taking of a single specimen of the Trieste species, *D. græffei* Bgh., at Naples. The close similarity of these two, the differences being practically slight ones of color details alone, warrants the conclusion that they are but variants of the same species. Their relation to *Drepania fusca* Lafont cannot at present be determined until an anatomical study of the latter has been made. In 1892 Bergh listed the three species as identical, in which case the first of them, *Drepania fusca* Lafont would have priority. Vayssière (1913) gives *Drepania* Lafont full generic rank, lists *D. tartanella* v. Ihering and *D. græffei* Bergh, but, curiously, makes no mention of the genotype *D. fusca* Lafont from Arcachon in his list of Opisthobranchs of France.

Drepania Lafont 1874

Drepania Lafont, 1874. Description d'un nouveau genre de Nudibranches des côtes de la France. <Journal de Conchyliologie. 3S, XIV, Vol. XXII, p. 369-370.

Bergh, R. 1881. Beiträge zu einer Monographie der Polyceraden II. Verh. d. k.-k. zool.-bot. Gesellschaft in Wien. Jahrg. 1880, p. 9-12. Taf. X, F. 10-15.

von Ihering, H. 1885. Beiträge zur Kenntniss der Nudibranchien des Mittelmeeres. II. Malacozool. Blätter, N.F. 8, p. 36-39, Taf. I, F. 2, Taf. II, F. 8, 9.

Bergh, R. 1892. System der Nudibranchiaten Gasteropoden, p. 164-165.

Vayssière, A. 1913. Mollusques de la France et des Régions voisines, I. p. 356-357. Pl. 37, F. 5-6.

Body limaciform; rhinophores perfoliate, non-retractile, each with a basal external process; branchiae trifoliate, simply pinnate, on each side a single, extrabranched appendage; tentacles digitiform; foot narrow, its anterior angles produced.

Labial disc armed on each side with a mandibular lamella, with denticulate margin. Radula very narrow, the rhachis naked; a single pleural tooth on each side with an elongate denticulate margin. Buccal ingluvies present. Glans penis armed with a series of hooks.

1. *Drepania fusca* Lafont, Bay of Biscay, Arcachon.
2. *D. graeffei* Bergh, Adriatic Sea, Trieste, Naples.
D. tartanella, von Ihering, Bay of Naples.
3. *D. velox*, (Cockerell), La Jolla, California.

The original generic description of Lafont (1874) is as follows:

"Corpus molle, laeve, supra convexum, postice acuminatum; caput arcuatum; tentacula antica cylindrica; tentacula superna clavata, medio lamellosa, appendice falciformi, ad basin munita; branchiae 3, plumosae, appendice laterali, falciformi, utrinque munitae; pes angustus, superne dilatus et utrinque productus; orificium genitale infra tentaculum dextrum superum situm."

Bergh (1881) added to this diagnosis the general features of the radula, the mandibular plates, and the penis armature, with the doubtful statement that the buccal ingluvies is rudimentary. In his single specimen, 4.5 mm. in length, it may have so appeared, but in the one I have studied it is well developed. Hence I have modified the genus diagnosis of Bergh (1892) "buccal ingluvies rudimentary" to what is given above. The generic characters as given by Vayssière (1913) are substantially the same.

Drepania velox (Cockerell)

Thecacera velox Cockerell. Cockerell, T. D. A. 1901. Three New Nudi-branches from California. "Journal of Malacology", VIII, 3, p. 87.

The original description published by Cockerell is as follows:

"Length about 12 millim., narrow, general form of *T. pennigera*. White, marked with black stripes, appendages tipped with orange. Foot tentacles and oral tentacles both long, the first white with a purple-black line beneath, continuous with the lowest body-stripes; oral tentacles with the apical three-fourths bright orange. Rhinophores laminated, with a terminal finger-like process; apical third (including more than half of the laminated portion) bright orange. Rhinophore sheath taking the form of a thickened tentacle, about as long as the rhinophore, lateral of the rhinophore and curling behind it; this pseudotentacle is purple-black above and white beneath, with the end broadly orange; the anterior lobe of the sheath, found in *T. pennigera*, is wholly wanting in *T. velox*. Appendages latero-posterior to branchiæ formed as in *T. pennigera*, with the apical half orange (a small black spot beneath at the base of the orange), the upper side, from the base of the orange forward, with a broad purple-black stripe, these stripes passing forward and joining in the middle line of the back anterior to the branchiæ, thence sending a short process forward, and another backward on to the median branchial plume, meeting the orange of its extremity. Branchial plumes three, about as in *pennigera*, bipinate, the lateral ones with a purple-black patch and a little orange mark beyond; the middle one broadly orange at the end. Hind end of foot bright orange, the black bands stopping abruptly at the orange. The purple-black longitudinal stripes are a dorsal and two on each side; the dorsal begins very broadly on the front of the head, and thence narrows until it ends some distance before the branchiæ; posterior to the branchiæ it is continued, and goes nearly to the end of the foot. The subdorsal stripes are interrupted in the region of the branchiæ, but otherwise are nearly entire. There are very short stripes in the area between the dorsal and subdorsal stripes, about the middle of the anterior part of the back. The lateral stripes border the narrow sole, and are continuous, but end before the subdorsal ones."

The above description of the color markings and general external topography given by Cockerell is clear, but he evidently made no anatomical study of the animal, and was led astray by the superficial resemblance to *Thecacera* which it shows, overlooking, however, the very significant fact that the rhinophores are not retractile within sheaths, and that what he interpreted as representing such a sheath is actually nothing of the sort, but an external, basal, finger-like process.

For the determination of the subfamily as between the Polycerinae and the Goniodoridinae, a simple, anatomical examination of the pharyngeal bulb must be made to ascertain the presence or absence of an ingluvies, or crop-like diverticulum, characteristic of the Goniodoridinae. This, together with

a study of the radula would have fixed the systematic position without question, another illustration of the danger of relying solely upon external characters in identifying these beautiful animals. These become all the more untrustworthy in preserved material which often loses all semblance of its living form and color.

The specimen from Dr. Johnson was received in vigorous living condition, despite its journey by mail. After a study of its external form and coloration, it was preserved in formalin-alcohol, in which the black and orange markings remained nearly unchanged. The total length of the extended living specimen, when crawling freely, was 16 mm; in the preserved condition it shortened to 8.3 mm. The general shape (Pl. 35, figs. 1, 2) is limaciform, smooth, arched above, the sides being but slightly set off from the margin of the foot. The branchial plumes are nearly midway of the length of the animal; they are three in number, bipinnate, in part simply pinnate, non-retractile into a sheath, and are directed obliquely upward and backward. Immediately in front of the branchial plumes is a well marked cardiac elevation from the sides of which, on either side, a finger-like blunt tapering process curves horizontally backward beside and behind the plumes. The rhinophores are 2 mm. in length, clavate, perfoliate with 10-12 leaves, the stalk above terminating in a blunt point. External to the base of each rhinophore is a blunt, cylindrical or very slightly tapering process, two-thirds of the length of the organ, horizontal for the most part, and curving around on the dorsum behind the rhinophore. It is 1.2 mm. in length, and exhibits but slight movement. The interpretation of this structure as a part of a rhinophore sheath led Professor Cockerell astray. The rhinophore of *Thecacera* is retractile into a large and distinct sheath, the margin of which is prolonged into two lobes. His view that this basal, external process represents one of these lobes cannot be held valid, since the rhinophore in this animal and in *Drepania* is non-retractile into a sheath, no trace of any such structure being present. They are clearly homologous, however, to the basal processes of the rhinophore found in the allied genus *Ancula*.

The outer angles of the margin of the head are prolonged into a tentacle-like process on either side, 1.1 mm. in length,

directed obliquely forward, outward and upward. These are not actively used as tactile organs, as are those formed by the angles of the foot immediately below, but seem more rigid, and comparable to the velar processes of *Polycera*. They cannot be termed oral tentacles in the strict meaning of the term.

The anterior angles of the linear foot are prolonged into long tapering processes, 1.4 mm. in length, slightly grooved ventrally (Pl. 35, fig. 3) throughout their full length. These are kept in active motion, being constantly in use as tactile organs, exploring in every direction as the animal moves. No black line, such as described by Cockerell, was found in the specimen at hand.

The anal opening is median, behind and included within the arc formed by the bases of the branchiae. The minute renal opening is close beside it. The reproductive openings are on the right side, far forward, below and slightly in front of the rhinophore.

The general ground color of the living animal is a translucent gray. The terminal one-third of the rhinophores, the terminal one-third of their basal processes, nearly the whole of the anterior, head margin processes, the tips of the branchiae and the terminal one-fourth of their lateral, basal appendages, and the tip of the tail are all a deep, rich orange. Five narrow longitudinal stripes of black, an unpaired median, a paired dorso-lateral and a lateral pair form very striking markings. The median band of black extends from the frontal margin backward, between the rhinophores to the cardiac elevation in front of the branchiae, where it joins a crescentic transverse band, which extends out on the dorsal surface of the lateral, branchial appendages through two-thirds of their length. Behind the branchiae, the median stripe extends nearly to the tip of the tail. The paired dorsolateral bands extend from immediately behind the basal processes of the rhinophores along the dorsolateral surface of the body nearly to the tip of the tail, being interrupted opposite the lateral branchial appendages for a short distance. The lateral paired bands extend from the sides of the head, immediately behind and below the head margin processes along the body parallel to the foot, with slight interruptions, toward the tip of the tail, which they do not reach. These five

longitudinal stripes of black vary in width along their course, and are probably frequently interrupted by slight breaks of continuity in some individuals. Midway between the rhinophores and the branchial plumes, on either side of the dorsal median band, is a short stripe of black. The dorsal surface of the basal appendages of the rhinophores bears a stripe of black extending from its base to the terminal orange extremity. The axis of each branchial plume bears a short, linear spot of black, in one case double, upon its outer, basal surface.

In alcohol the black stripes remain unchanged, the orange color becomes much paler.

In the endeavor to preserve the specimen as much as possible, no detailed study of its anatomy has been attempted. The pharyngeal bulb shows at once the well developed, muscular crop-like enlargement (Pl. 35, fig. 4,c) characteristic of the Sub-family Goniodoridinae, and not of the Polycerinae, to which *Thecacera* belongs. The bulb measured 0.55 mm. in length and 0.45 mm. in width. Close at the anterior end of the oesophagus, on either side, lie the small, rounded saccular salivary glands (Pl. 35, fig. 4,g). The radula sack projects but slightly as a rounded eminence below and behind in the median line. (Pl. 35, fig. 4,s) The oral tube is short and rather wide, its opening being a vertical slit, guarded on either side above by a triangular, mandibular plate bearing closely set, short spines, directed forward, the most anterior, marginal ones visible from in front, as in Pl. 35, fig. 6, where they project freely across the upper half of the opening of the tube, as seen from in front. The plates are approximately a right angled triangle in form, slightly wider than long (Pl. 35, fig. 5), and are covered throughout the most of their extent by these short, pointed, chitinous spines. Those nearest the anterior margin are the strongest and best developed, reaching 0.030 mm. in length and 0.007 mm. basal diameter, (Pl. 35, fig. 7). Those farther back are considerably less strong and prominent, many being quite slender. The lateral plates represent thickenings in the cuticle of the mouth cavity and are unconnected with each other, save by the general cuticular lining. Bergh (1881) describes and figures a similar armature for *Drepania graeffei* Bgh., cordate in shape and with a denticulate anterior border, the remaining surface of

the plate being strongly netted, as if made up of thickened ridges and not of projecting spines, as here.

The radula is short and rather broad, its total length measuring 0.6 mm. It is made up of 24 transverse rows of teeth, each row being made up of a single lateral tooth on either side of a naked rhachis, the dental formula thus being $24 \times (1.0.1)$. Each lateral tooth (Pl. 35, figs. 8-10) is strongly convex in front, concave behind, and wide from side to side. The rather narrow, crescentic base rests obliquely upon the basal membrane, its inner end, nearest the rhachis, being in advance of the outer one. From the anterior margin of the base arises a broad and thin convex expansion, its upper margin being coarsely and irregularly denticulate, and culminating in a strong, pointed cusp, borne on the thickened, outer margin, and directed obliquely inward and backward toward the median line. External to this cusp the shell-like plate is expanded into a smaller wing; on the inner side the margin slopes rapidly downward as a crescentic ridge toward the median end, and bears a single series of some 8 to 11 irregular, sharp denticles, triangular in form and of varying height. In Pl. 35, fig. 8 a typical lateral tooth from the right side of the radula is shown, as seen from above; in fig. 9 a similar tooth is seen from in front and slightly below; while in fig. 10 the same tooth is represented after having been rotated toward the right, so as to show most of its basal surface and the full extent of the strong outer cusp, while the inner denticulate ridge is nearly concealed by the uptilted outer margin. The real form of these teeth is by no means evident at first sight, and the radula requires prolonged study before its structure is clear. The width of one of the lateral teeth from the first or oldest row of the radula is 0.033 mm., that of one from the 9th row is 0.065 mm., while in one of the youngest rows, toward the end of the radula sheath, it reaches 0.084 mm. In *D. graeffei* Bgh., according to Bergh (1881), the total number of rows in the radula is 51, over twice as many as here, and the width of the oldest lateral tooth is 0.055 mm., that of the youngest 0.16 mm. The number of denticles is much larger, varying up to 22-24 on each tooth, the whole organ being somewhat straighter and less convex than in this Californian species. Von Ihering (1885) states

that the radula of *D. tartanella* von Ih. is identical with that of *D. græffei* Bgh., save for the somewhat less number of denticles, as is shown by his figure. He gives the width ("length") of a tooth as 0.085 mm., without indicating from which part of the radula the tooth in question is taken.

The short oesophagus (Pl. 35, fig. 4, *oe*) leads directly back into the stomach, which is completely inclosed in a deep furrow in the dorsal surface of the liver. The intestine is directed forward for a short distance from the posterior end of the stomach, thence looping sharply backward it passes in a straight course to the anal opening in the median region of the back, just behind the crescentic line of origin of the branchial plumes. Close to it is the renal pore, connected by a very short tube to the roomy, simple kidney sack, which in turn, communicates with the overlying pericardium by the small, elliptical renal syrinx.

The large eyes lie deep below the integument, close beside the cerebral portion of the cerebro-pleural ganglia, to which they are attached by very short optic nerves. Close behind, and slightly below the eyes, are the sessile otocysts, filled with minute otoconia. The cerebro-pleural ganglia are fused into a single ovoid mass, 0.3 mm. long by 0.18 mm. in greatest diameter, with only a shallow furrow obscurely indicating the approximate line of union. The cerebral portions of each side are connected above the oesophagus by a short and rather strong cerebral commissure. Below the cerebro-pleural ganglia are the large spherical pedal ganglia, 0.165 mm. in greatest diameter, and united to those above by the usual cerebro-pedal and pleuro-pedal connectives. The pedal pair is united below the oesophagus by a very short pedal commissure. The lack of material prevented the working out of further details.

The ovotestis is in close contact with the liver, the superior and anterior surfaces of which it nearly conceals. The anterior end overlaps the anterior genital complex, the superior oval face of the latter being beveled obliquely backward and downward. Fig. 11 of Pl. 35, shows the relationships of the conduits of the anterior genital complex as seen in dorsal view, they being displaced somewhat to render the connections evident. The accessory glands have been omitted for

clearness. The short and slender hermaphroditic duct *hd*, passes directly to the ellipsoidal hermaphroditic ampulla which lies upon the dorsal, right side of the complex. From its anterior end, in close contact with the underlying nidamental-albumen gland mass the hermaphroditic ampulla (*h. a.*) narrows abruptly to a slender duct which divides into the vas deferens and the oviduct. The oviduct passes at once into the lumen of the albumen gland, the vas deferens, *v.d.*, thickens rapidly into a white, thick-walled, glandular tube, passes backward to the left of the hermaphroditic ampulla, describes a close loop at the posterior end of the anterior genital complex, returns forward along its left border to the anterior end, narrows slightly and passes into the preputium, *p*. The latter is ca. 0.5 mm. long by 0.15 mm. in greatest diameter, not as thick as the prostatic portion of the vas deferens, and contains the strongly retracted cylindro-conic glans. In Pl. 35, fig. 13, the wall of the preputium, *p*, is dissected away, except at the base, exposing the glans, *g*. In fig. 12 the distal end of the glans is represented under a higher magnification as a transparent preparation. The lumen is lined by a series of closely set, curved spines, the tips of which are directed outward. These extend back for a distance of 0.14 mm. from the tip, the longest and strongest, 0.03 mm. in length, with a basal diameter of 0.006 mm., being farthest away from the opening, forming a narrow band which is succeeded by an intermediate zone of about one half the height of the longest, and these in turn, by a more distal band of longer and more slender ones. Typical spines from each of these three regions are shown in detail in Pl. 35, figs. 14 and 15. For *D. graeffei* Bergh (1881) describes and figures a glans armature of hooks, much more irregular in form, notched or toothed and reaching a height of 0.015 mm. In *D. tartanella* according to von Ihering (1885) the armature is made up of simple hooks ranging from 0.021 to 0.028 mm. in height.

The other branch of the hermaphroditic duct, beyond the hermaphroditic ampulla, is the very short oviduct, which opens at once into the lumen of the albumen gland, the cut end of the duct being shown in fig. 11. Close by it emerges the slender, uterine duct (Pl. 35, fig. 11 *u. d.*) which receives the very short duct of the nearly spherical spermatocyst, *s. c.*, 0.4 mm.

in length by 0.34 mm. in diameter. Beyond this point the uterine duct closely parallels the vaginal duct to which it is attached, and opens into the larger, nearly spherical spermatheca, *s*, lying on the right, upper surface of the complex. From the spermatheca the vaginal duct, *vag. d.*, leads to the vagina into which it dilates, opening externally close behind the orifice of the preputium, on the right side of the head, opposite and below the base of the right rhinophore. Immediately below it is the opening of the external duct of the mucus gland. The maximum diameter of the vagina is 0.135 mm., the diameter of the vaginal duct near the spermatheca is 0.06 mm., the total length of both vagina and vaginal duct from the external opening to the spermatheca is 1.78 mm.

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PLATE 35

- Fig. 1. *Drepania velox* (Cockerell) in side view, drawn from living specimen. $\times 6$.
- Fig. 2. *Drepania velox* (Cockerell) in dorsal view, drawn from living specimen. $\times 6$.
- Fig. 3. Ventral view of anterior region of body. $\times 6$.
- Fig. 4. Pharyngeal bulb in side view, freed from muscular attachments and the nerve collar. *c*, the buccal ingluvies, or muscular crop; *s*, the posterior median projection containing the radula sack; *oe*, the anterior end of the oesophagus; *g*, the saccular salivary gland. $\times 30$.
- Fig. 5. Inner surface of the left mandibular plate showing its armature of spines. $\times 122$.
- Fig. 6. Front view of oral tube cuticle, the muscles having been removed. The two mandibular plates, *p*, are seen obliquely from the outside, their anterior marginal spines showing at the sides of the upper half of the mouth opening. $\times 122$.
- Fig. 7. A group of the marginal spines of a mandibular plate under higher magnification. $\times 278$.
- Fig. 8. Typical first lateral tooth from middle region of right side of radula, as seen from above. $\times 450$.
- Fig. 9. Similar lateral tooth seen obliquely from in front and below. $\times 450$.
- Fig. 10. The same lateral tooth rotated to the right, showing the external face and a part of the base. $\times 450$.
- Fig. 11. Relations of the reproductive conduits in the anterior genital complex. For the sake of clearness the albumen and mucus glands have been omitted and the ducts are spread apart and separated from their closely packed condition. *h.d.*, hermaphroditic duct leading from the ovotestis behind; *h.a.*, hermaphroditic ampulla; at the anterior end it narrows and divides into the short oviduct, shown as a cut end, which enters the albumen gland at once, and a very much longer vas deferens, *v.d.*, the thicker segment of which forms the highly glandular prostatic portion; *p*, the penis, shown in detail in Figs. 12 and 13; *s.c.*, the spermatocyst, opening by a very short duct into *u.d.*, the uterine duct, which extends from its emergence from the albumen gland to the spermatheca, *s*; *vag.d.*, the vaginal duct, dilating distally into the vagina, *v.* $\times 20$.
- Fig. 12. Distal end of glans penis viewed as a transparent object; *a*, its armature of spines, probably eversible. $\times 200$.
- Fig. 13. Penis. The wall of the preputium *p*, has been cut away so as to disclose the glans, *g*, within. The lumen is faintly seen extending through the organ and dilating toward its tip, where the armature shown in Fig. 12 is borne. $\times 80$.
- Fig. 14. Detail of typical spines of the penis armature, taken from the region *a* in Fig. 12. $\times 380$.
- Fig. 15. Detail of typical spines from the distal end of the penis armature. $\times 380$.